# Electrons levels and sublevels. Quantum number. Electron configuration





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• Make a list of inferences about any properties of objects in the box.

• How could you learn more about the objects in the box without opening the box?

• Scientist face these same questions as they try to learn more about atoms.

# **Quantum Numbers**

- **Quantum numbers** specify the address of each electron in an atom. There are four types of quantum numbers:
- 1. Principal quantum number,  $n \rightarrow energy level (shell)$
- 2. Secondary quantum number,  $l \rightarrow subshell (s, p, d, f)$
- 3. Magnetic quantum number,  $m_1 \rightarrow orbital$
- 4. Spin quantum number,  $m_s \rightarrow spin$  type of
  - There are no two electrons in an atom that can have the same four quantum numbers. Each electron has a unique address, like a family living in a flat. This is Pauli's Exclusion Principle.

### 1. The principal quantum number, n

- determines the size and energy of an atom (larger n means bigger atoms and higher energy),
- can take an integer value n = 1, 2, 3, 4 ... or (K, L, M, N...),
- all electrons in an atom with the same value are said to belong to the same shell.

### 2. Secondary quantum number, l

- determines the overall shape of the orbital within a shell
- affects orbital energies (bigger l = higher energy)
- all electrons in an atom with the same value of 'l' are said to belong to the same subshell
- has integer values between 0 and n-1
- may be called the "orbital angular momentum quantum number"

### 3. Magnetic quantum number, ml

- determines the orientation of orbitals within a subshell
- does not affect orbital energy
- has integer values between -I and +I
- the number of ml values within a subshell is the number of orbitals within a subshell
- s, p, d and f subshells includes 1, 3, 5 and 7 orbitals respectively.

### 4. Spin quantum number, ms

- each orbital may contain two electrons at most
- several experimental observations can be explained by treating the electron as though it were spinning
- spin affects the electron behave like a tiny magnet
- spin can be clockwise (+1/2) or counterclockwise (-1/2)

# **Solving problems**

Example 1

- Find the values of quantum numbers for hydrogen atom. Example 2
- Show the values of possible quantum numbers for magnesium atom.( 12Mg)

### Electron configuration

In 1925 Wolfgang Pauli stated his exclusion principle;

- 'In the same atom, two electrons may not have identical sets of all quantum numbers.'
- According to this principle, the quantum numbers, n, l,  $m_p$  and  $m_s$ , can *never* be identical for two electrons in an atom.

#### The Aufbau process

• The Aufbau principle basically states that the lowest energy orbitals are filled first.

#### Hund's rule states that;

• the electrons are distributed among the orbitals of a subshell of the same energy in a way that gives the maximum number of unpaired electrons with parallel spin.

1s<sup>2</sup>, 2s<sup>2</sup>, 2p<sup>6</sup>, 3s<sup>2</sup>, 3p<sup>6</sup>, 4s<sup>2</sup>, 3d<sup>10</sup>, 4p<sup>6</sup>, 5s<sup>2</sup>, 4d<sup>10</sup>, 5p<sup>6</sup>, 6s<sup>2</sup>, 4f<sup>14</sup>, 5d<sup>10</sup>, 6p<sup>6</sup>, 7s<sup>2</sup>, 5f<sup>14</sup>, 6d<sup>10</sup>, 7p<sup>6</sup>

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- Ca
- Co
- ......3d5 4s2
- n=3, l=1

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- Zn
- Br
- .....3s2 3p6
- n=2, l=0